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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER	
DETSCHEL, MARISSA	

ART UNIT	PAPER NUMBER
2877	

DATE MAILED: 10/19/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

AK

Office Action Summary	Application No.	Applicant(s)	
	10/673,058	HWANG ET AL.	
	Examiner	Art Unit	
	Marissa J. Detschel	2877	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *September 26, 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-47* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-18,20-31,33,34 and 36-47* is/are rejected.

7)☒ Claim(s) *17,19,30,32 and 35* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *02/25/04*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Information Disclosure Statement

The information disclosure statement filed on February 25, 2004 has been fully considered by the examiner.

Specification

The disclosure is objected to because of the following informalities: A blank space appears throughout the specification in reference to the nonprovisional patent application number. The appropriate number should be filled in this space.

Appropriate correction is required.

Claim Objections

Claim 12 is objected to because of the following informalities: The limitation "the switching mechanism" appears in this claim, and there is insufficient antecedent basis for this. Examiner suggest making claim 12 dependent on claim 11.

Claim 17 is objected to because of the following informalities: The word "intregration" is misspelled is this claim, as used in "time delay intregration mode."

Claim 30 is objected to because of the following informalities: Two periods appear at the end of this claim. Furthermore, the limitation "the illumination beam" appears in the first two lines of the first part of this claim, and there is insufficient antecedent basis for this.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claim 14 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The final part of this claim mentions "a second signal representation," and it is not disclosed as to where this signal is generated.

Claim 36 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The second part of the claim states the limitation "an integrated interferometric module configured for performing simultaneously at least one of a) interferometric and intensity based inspection using the first illumination beam, and b) intensity based microscopic inspection using the second illumination beam." It is not possible to simultaneously perform at least one of two things.

Claims 15-19, which are dependent from claim 14, and claims 37-44, which are dependent from claim 36, inherit the problems of this claim, and are therefore also rejected under 35 U.S.C. 112, second paragraph.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 20-31, 33, and 34 are rejected under 35 U.S.C. 102(b) as being anticipated by Wihl et al. (USPN 5,572,598).

Regarding claims 20, 26, and 33, Wihl discloses an interferometric inspection system that comprises an illumination module (30) configured to generate a first illumination beam for interferometric inspection, an interferometric microscope (16) configured to split (60) the illumination beam into a test beam and a reference beam respectively directed to and reflected from a wafer (14) and a reference mirror (118) and to combine the test and reference beams into an interference image having spatial fringe patterns (column 13, lines 22-27), and at least one time delay integration mode sensor (34, 36) configured to receive the interference image having spatial fringes (column 10, lines 26-36). Wihl teaches the use of a time-delay integration sensor in place of the linear detectors of the inspection system (column 14, lines 14-21).

In regards to claims 21 and 28, Wihl's interferometric inspection system further comprises a movable stage (12) to support the wafer (14) and wherein the apparatus is configured to synchronize the movement of the stage with the movement of the interference image on the sensor. (column 10, lines 26-36)

In regards to claims 22, 27, 30, and 33, Wihl discloses an interferometric inspection system that comprises an interferometric microscope module (16) configured for splitting (60) an illumination beam (30) into a test beam directed to the semiconductor wafer (14) and a reference beam towards a reference mirror (118), and combining into a combined beam the test beam reflected from the wafer and the reference beam reflected from the reference mirror, the combined beam forming an interference image, (column 13, lines 22-27) wherein the reference mirror is configured to be adjustably titled with respect to the incident reference beam to generate fringes in the interference image having an orientation different from a direction of a pattern on the wafer (column 11, lines 33-37). An image sensor (34, 36) is also configured to

receive the interference image and to generate a signal for deriving phase information in Wihl's system. (column 11, lines 41-46)

In regards to claim 23, the movement of the reference mirror of Wihl's device is adjusted to maintain, as the wafer is moved by the stage, a constant optical path difference between the test beam and the reference beam for a selected portion of the interference image pertaining to a corresponding portion of the wafer (column 11, lines 33-37).

Regarding claims 24 and 29, Wihl's interferometric inspection system further comprises a movable stage (12) to support the wafer (14) and to induce the movement of the interference image relative to the sensor, wherein the spatial fringes are oriented on the sensor so that the spatial fringes are aligned in the direction of the induced movement. (column 10, lines 26-36 and Figure 3)

In regards to claim 25, Wihl's sensor is configured in time domain integrated mode for both phase based phase based and intensity based measurements. (column 7, lines 20-38)

Regarding claims 31 and 34, Wihl's system inspects a pattern on a wafer that is a repeating pattern having a dominant direction (Figure 10) and the orientation of the fringes relative to the dominant direction is optimized during inspection. (column 11, lines 33-37)

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1, 7, 36-40, and 45-47 are rejected under 35 U.S.C. 103(a) as being unpatentable over Rostvall.

In regards to claim 1, 36, 37, and 45, Rostvall discloses an optical device with an illumination module (11 and 21) configured to generate a first illumination beam for interferometric inspection in a first mode and a second illumination beam for intensity based microscope measurement in a second mode. Rostvall's device is configured for interferometric inspection mode for splitting (12) a first beam into a test beam directed to the sample (10) and a reference beam towards a reference mirror (13), and combining the test beam reflected from the sample and the reference beam reflected from the reference mirror to form an interference image (column 1, line 65 to column 2, line 10) and to reflect the second illumination beam from the sample (column 2, lines 35-39). At least one image sensor (14 and 22) is configured to receive the interference image and the reflected second illumination beam from the integrated interferometric microscope module. Furthermore, regarding claim 36 specifically, Rostvall's device uses a second illumination beam that has a different frequency spectrum than the first illumination beam (column 1, lines 56-58), and includes a first image sensor (14) configured to receive an interference image having spatial fringes based on the first illumination beam (column 2, lines 7-10) and a second image sensor (22) configured for receiving a second microscopic image as based on the second illumination beam, the second microscopic image being formed simultaneously with the formation of the interference image on the first sensor (column 2, lines 35-39). It is to be understood that a reflected image of the sample on a sensor represents a microscopic image.

In regards to claim 7, the image sensor (14) is configured in a frame capture mode to acquire inspection signals (column 2, lines 22-24) for phase based inspections using a spatial fringe analysis technique (column 2, lines 18-21).

Regarding claims 38, 40, and 46, the first illumination beam of Rostvall's device is generated by a laser source, and the second is generated by a broadband source (column 1, lines 56-58, column 2, lines 35-37).

In regards to claim 39 and 47, the first illumination beam is a narrowband beam and the second illumination beam is generated by a broadband source (column 1, lines 56-58, column 2, lines 35-37).

Regarding all of these claims rejected under 35 U.S.C. 103(a) mentioned thus far, Rostvall discloses the use of the device for checking flatness and smoothness of an item, and specifically mentions polished metal surfaces (column 1, lines 7-9). It would have been obvious to one skilled in the art at the time of the invention to use Rostvall's device to test semiconductor wafers.

Claims 2-4, 6, 8-11, 13, 41, and 44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Rostvall (USPN 5,583,639) as applied to claims 1 and 36 above, and further in view of Wihl (USPN 5,572,598).

In regards to claims 2 and 3, Rostvall does not teach the use of a processing module configured to generate complex field information corresponding to the semiconductor wafer from the interference image signal. Rostvall does disclose the use of a second image plane (22) configured to generate a microscope inspection signal corresponding to the intensity of the reflected second illumination beam (column 2, lines 37-39). Wihl discloses the use of an

electronic subsystem that interprets the interference data collected by the detector (36) to determine variations of thickness of phase shift material covering a given point on the sample inspected. (column 7, lines 35-41) It would have been obvious to one of ordinary skill in the art at the time of the invention to apply the electronics subsystem of Wihl to Rostvall's device in order to inspect a sample for defects in a more accurate way.

Regarding claims 4 and 10, Rostvall does not disclose the use of a reference mirror that is tilted with respect to the incident reference beam to generate fringes in the interference image relative to structures in the image on the sensor. Wihl's device discloses the use of a reference mirror that is adjustably titled with respect to the incident reference beam to generate fringes in the interference image that are not parallel to the plane of the substrate (column 11, lines 33-37). It would have been obvious to one of ordinary skill in the art at the time of the invention to apply the tilted mirror of Wihl's device to Rostvall's device in order to generate the fringes used for interferometric measurement during inspection.

Regarding claim 6, 11, 41, and 44 Rostvall does not disclose the use of a shutter to isolate the reference mirror from the optical path of the reference beam that is provided to switch the operation of the inspection system between interferometric and microscopic measurement. Wihl discloses the use of a shutter (66) located along the path of the reference beam before the reference mirror (see figure 1). This shutter remains open during phase measurement mode (i.e. interferometric measurement mode) (column 5, lines 50-52), and closed during reflected light inspection (i.e. microscopic measurement) (column 7, lines 15-16). It would have been obvious to one of ordinary skill in the art at the time of the invention to apply the shutter of Wihl's device to Rostvall's device to switch between interferometric and microscopic measurement modes,

allowing for a cheaper way to take two separate measurements in one apparatus, as opposed to buying a separate apparatus for each measurement.

In regards to claims 8, 9, and 41, the image sensor of Rostvall's device is not configured in time delay integration mode to acquire inspection signals for phase based inspection. Wihl teaches the use of a time-delay integration sensor in place of the linear detectors of the inspection system. This allows for coherence in the X and Y-directions to be destroyed. (column 14, lines 14-25) It would have been obvious to one of ordinary skill in the art at the time of the invention to apply the time delay integrating sensor of Wihl's device to Rostvall's device to gain a clearer measurement signal.

Regarding claim 13, Rostvall's device does not include a moveable stage to provide movement of the sample being inspected so that the spatial fringes are aligned with the direction of movement of the stage. Wihl's device includes a stage (12) movable in the x and y-directions (column 10, lines 26-36) to support the substrate. Due to the tilted mirror of the device, the wavefront of the reference beam is not parallel to the plane of the substrate, and fringes are formed as the sample is scanned. (column 11, lines 33-37) These fringes have to be aligned with the direction of the movement of the stage in order to create a clear interference pattern. It would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize the stage of Wihl's device in Rostvall's device in order to enhance the accuracy of the measurement.

Claims 5 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Rostvall as applied to claim 1 above and further in view of Ai, et al. (USPN 5,471,303). Rostvall does not disclose the use of a switchable illumination source to switch between a first illumination beam

and a second illumination beam in an inspection device. Ai discloses the use of an illumination module (34 and 36) capable of switching between a white-light source and a single wavelength source for separate types of measurement in an interference microscope (column 9, lines 11-14). This switchable source allows for each of the two sources provided to take two separate types of measurements without the potential of noise from the signal of the other source. It would have been obvious to one of ordinary skill in the art at the time the invention was made to provide the switchable illumination source of Ai to Rostvall's device to create a single device that performs two separate types of measurement without mixing the signals, resulting in cleaner measurements and an economically manufactured device.

Claims 14, 15, 17, and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wihl (USPN 5,572,598).

Regarding claims 14, 15, 17, and 18 Wihl discloses a device for inspecting a wafer by combining a test wave reflected from a wafer and a reference wave reflected from a reference mirror to produce an interference optical image on a sensor (column 13, lines 22-27). The sensor, which can be in time delay integration mode (claim 17), converts the interference optical image into complex field information (column 7, lines 35-41). Wihl's system also performs microscopic inspections from reflected light off the substrate (column 7, lines 11-15). Wihl also teaches the concept of die-to-die inspection, where two areas of a substrate having identical features are compared with respect to each other and any substantial discrepancy is flagged as a defect. In regards to claim 17, Wihl teaches the concept of die-to-database inspection mode where a defect is found by comparing the die under test with corresponding graphics information from a database. (column 4, lines 41-50) From this, Wihl's device is capable of performing

interferometric inspection of a first section of a substrate and generate a first signal representation of the complex field information, measure the intensity of a test wave reflected from a second portion of the wafer using microscopic techniques, and generate a third signal representation from this measurement, and, finally, generate a second signal representation from a database. Wihl's device is also capable using these three signals in comparison to each other to find the defects through die-to-die and die-to-database inspection. Regarding claim 18 specifically, Wihl's device discloses the use of a reference mirror that is adjustably titled with respect to the incident reference beam to generate fringes in the interference image that are not parallel to the plane of the substrate (column 11, lines 33-37). It would have been obvious to one of ordinary skill in the art at the time of the invention to use Wihl's device in such a manner to obtain accurate signals of defects in wafers.

Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Wihl (USPN 5,572,598) as applied to claim 14 above, and further in view of Rostvall (USPN 5,583,639). Wihl does not disclose the use of an image sensor in frame capture mode to acquire measurement signals for phase based measurements, but rather uses a laser scanning system. Rostvall uses an image sensor (14) configured in a frame capture mode to acquire inspection signals (column 2, lines 22-24) for phase based inspections using a spatial fringe analysis technique (column 2, lines 18-21). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the frame capture mode of Rostvall to acquire an entire signal all at once, rather than have to wait for the laser to finish scanning the substrate to get the same signal. This results in faster measurement times.

Claims 42 and 43 are rejected under 35 U.S.C. 103(a) as being unpatentable over Rostvall (USPN 5,583,639) as applied to claim 36 above, and further in view of Davidson (USPN 4,818,110). Rostvall discloses the use of a non-coherent light source as the source used in reflected light (i.e. microscopic) inspections (column 2, lines 35-37). A non-coherent light source is an example of both a broadband source and brightfield source. Rostvall does not disclose the use of such a source as the interferometric inspection source. However, Davidson uses a Xenon arc lamp (31) to produce white light Kohler illumination in an interference microscopy device used to measure integrated circuit wafer geometry (column 4, lines 34-36). The use of white light (i.e. broadband or brightfield illumination) allows for a signal-to-noise ratio that is not degraded by coherent speckle effects and also eliminates the possibility destructive interference that for certain thicknesses of transparent films. It would have been obvious to one of ordinary skill in the art at the time the invention was made to use the interferometric inspection light source of Davidson's device in the device of Rostvall to gain a highly accurate interferometric measurement for spatial fringe analysis.

Allowable Subject Matter

Claims 5, 12, 19, 32 and 35 are objected to as being dependent on a rejected base claim, but would be allowable is rewritten in independent form including all of the limitations of the base claim and any intervening claims.

As to claim 5 and 12, the prior art of record, taken alone or in combination, fails to disclose or render obvious the use of an illumination module that is configured to switch between the first and second illumination beams in an interferometric microscopic inspection system.

As to claim 19, the prior art of record, taken alone or in combination, fails to disclose or render obvious the method of maintaining a positioning of spatial fringe lines on a sensor that occurs in response to movement of the semiconductor wafer by a stage in an interferometric microscopic inspection system.

As to claims 32 and 35, the prior art of record, taken alone or in combination, fails to disclose or render obvious the use of an interferometric microscopic measurement system that inspects the pattern on a wafer that is a repeating pattern with two dominant directions which are orthogonal to each other, and having the fringes oriented at about a 45 degree angle relative to one of the orthogonal directions of the repeating pattern.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Marissa J. Detschel whose telephone number is 571-272-2716. The examiner can normally be reached on M-F 8:30am-5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Gregory J. Toatley, Jr. can be reached on 571-272-2059. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

HWA (ANDREW) LEE
PRIMARY EXAMINER

MJD